Table 3. Television Broadcasters Examined for Protection Analysis

Call Sign	Channel	City	Latitude NAD 27	Longitude NAD 27	ERP (kW)	Ant_AMSL (m)
WMBC	63 NTSC	Newton, NJ	41-00-43N	74-35-32W	5000	609
WNAC	64 NTSC	Providence, RI	41-52-14N	71-17-45W	3720	343
WPVI	64 DTV	Philadelphia, PA	40-02-33N	75-14-33W	500	456
WQPX	64 NTSC	Scranton, PA	41-26-06N	75-43-35W	3090	735
WEDY	65 NTSC	New Haven, CT	41-19-42N	72-54-25W	7.94	133
WUVP	65 NTSC	Vineland, NJ	40-02-30N	75-14-11W	4070	461
WFUT	68 NTSC	Newark, NJ	40-44-54N	73-59-10W	2630	437
WFMZ	69 NTSC	Allentown, PA	40-33-52N	75-26-24W	5000	464
WPXQ	69 NTSC	Block Island, RI	41-29-41N	71-47-05W	3470	272

The technical parameter definitions are:

ERP is the effective radiated power in units of kilowatts.

Ant_AMSL is the transmit antenna height above mean sea level (AMSL) in units of meters.

Figures 1 and 2 geographically reference the nine Grade B service contours with respect to the proposed Downstate New York area of operations. The contours were generated using FCC Office of Engineering and Technology (OET) TV Grade B contour data valid on February 25, 2005.

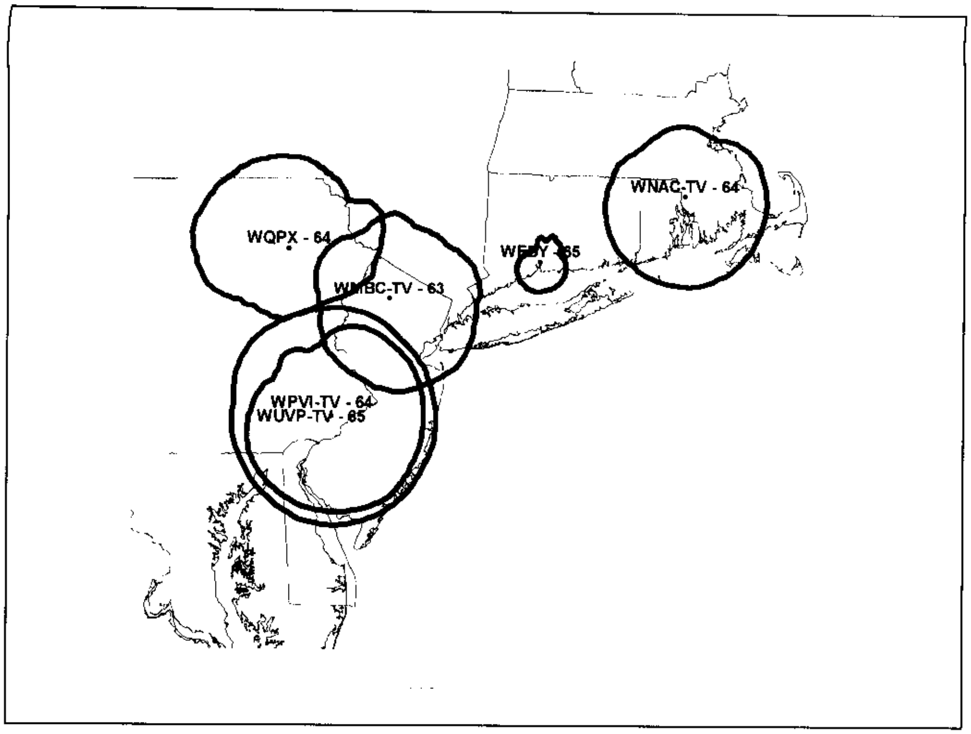

Figure 1. Television Stations Pertinent to Channel 64 Operations

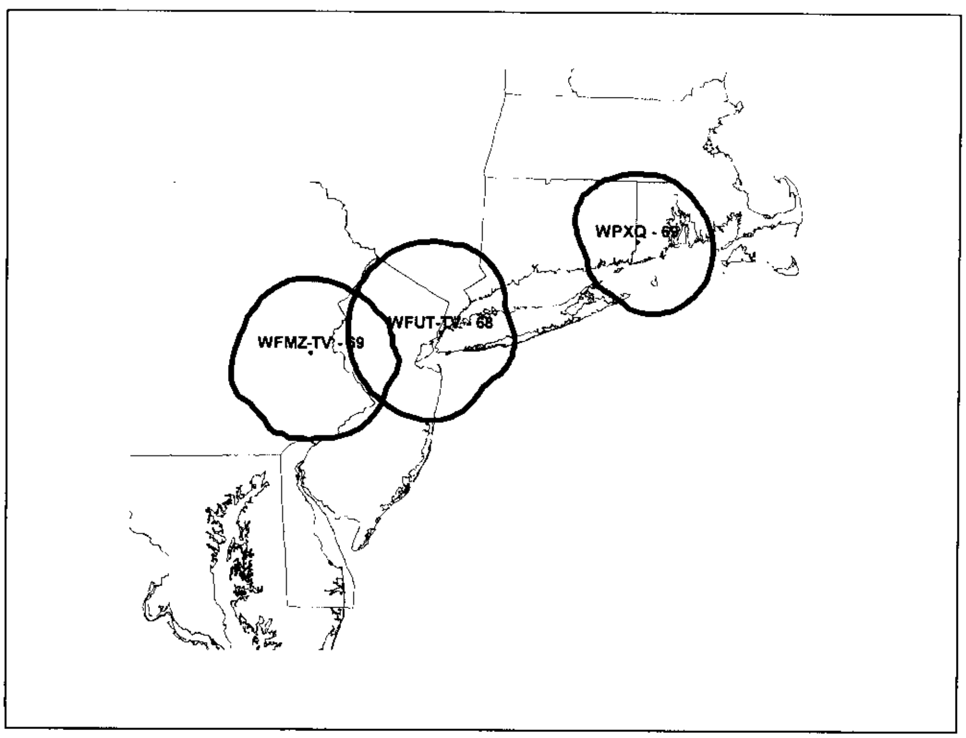

Figure 2. Television Stations Pertinent to Channel 69 Operations

OET Bulletin No. 69, *Longley-Rice Methodology for Evaluating TV Coverage and Interference* defines the Grade B median field strength F(50,50) at the service area contour for analog UHF television channels as

$$F(50,50) = 64\ \text{dB}\mu\text{V/m} - 20 \log_{10} [615 / (\text{channel mid-frequency in MHz})].$$

From the same reference, the Grade B median field strength at the service area contour for digital UHF television channels is defined as

$$F(50,90) = 41\ \text{dB}\mu\text{V/m} - 20 \log_{10} [615 / (\text{channel mid-frequency in MHz})].$$

Figures 1 and 2 make the public safety situation very clear why the channel 64/69 pairing is the most sensible spectrum sharing option available to New York State. Stations WMBC on channel 63 and WFUT on channel 68 have substantial Grade B service area intersection with the proposed public safety area of operations. Both stations must be lower adjacent channel (as opposed to co-channel) occupants with respect to the public safety 700-MHz channels in order to take maximum advantage of television receiver frequency selectivity characteristics.

Attachment 4, *Determination of Fixed Base Station ERP* is arranged as a matrix with each of the proposed downstate fixed base stations aligned to each of the six broadcast stations that are either adjacent channel or co-channel to the base stations. The matrix contains several compliance tests (i.e., separation distance, HAAT limitations, and ERP limitations) based on § 90.545 rules and § 90.309 tables and figures to determine if a particular fixed base station meets the protection criteria. The key outcome is found in the final column, **90.545 Engineering Study**, where <u>Y</u>es and <u>N</u>o are conclusive statements regarding whether the proposed 700-MHz fixed base station is a transmitting element in the interference protection analysis of a particular broadcaster.

A walk-through of Attachment 4 proceeds as follows. The first column **Station** identifies a specific broadcaster such as WMBC and the second column **NYS Site** then lists all 99 downstate fixed base station sites. It is noted the matrix is organized from the broadcasters' perspective, that is, each broadcaster can view the entire array of proposed downstate 700-MHz fixed base stations as a unit. The third and fourth columns, **TV Chan** and **Relative to Base Station,** give the television channel and whether it is adjacent or co-channel with respect to the fixed base station's frequency.

The fifth column **Actual HAAT (m)** restates the fixed base station's antenna height above average terrain in units of meters from Attachment 3. The sixth column **Actual HAAT >152 m** gives results, in terms of <u>Y</u>es or <u>N</u>o, of a test to determine whether the fixed base station is subject to an ERP reduction as required by *§ 90.545 (c)(2)(i) because the HAAT is in excess of 152.5 meters* elevation.

The seventh column **Actual Dist. (km)** provides the separation distance in units of kilometers between the television antenna tower and the proposed fixed base station location. The distance separation calculation method is given in 47 C.F.R. § 73.208 *Reference Points and Distance Computations*. The audit trail confirming the required procedure links § 90.545 (c)(1)(i) to § 90.309 (b)(3) to § 73.611 (d) and finally to § 73.208 (c). Separation distance is an input variable to assist determining the amount of ERP reduction from Figure B, *Power Reduction Graphs 40 dB Protection* found in § 90.309. The eighth column, **Actual Distance >209 km Co-Ch; >108 km Adj-Ch**, contains two tests, one for determining if the co-channel separation is greater than 209 km (from Table B in § 90.309) and one for determining if the adjacent channel separation is greater than 108 km (from Table E in § 90.309). A Yes result means the distance is great enough to exempt any ERP reduction regardless of HAAT whereas a No result means HAAT must be examined to determine whether an ERP reduction is necessary later to establish the maximum allowable ERP for that proposed fixed base station.

The ninth column **90.309 ERP Reduction Figure B (dB)** contains the reduction value to be applied later when determining the allowable maximum ERP. A Yes result from Column 8 and any HAAT less than 152.5 meters in elevation automatically is a zero (0.0) value, i.e., no ERP reduction. Where a finite value is given such as 5.5 dB that value was obtained from § 90.309 Figure B for separation distances in the range of 153 km to 209 km and will be applied later to establish the maximum allowable ERP. The separation distance range in § 90.309 Figure B does not cover all the physically real conditions that we are proposing in order to meet the system's coverage reliability requirements. Therefore, the reader will notice that numerical results are deliberately omitted in Column 9 for the cases where the HAAT exceeds 152.5 meters in elevation with a separation distance less than 153 km. We have instead resolved the issue by simply setting the maximum allowable ERP to zero.

The tenth column **Actual Distance <145 km Co-Ch; <96 km Adj Ch** contains two tests, one for determining if the co-channel separation is less than 145 km (from Table B in § 90.309) and one for determining if the adjacent channel separation is less than 96 km (from Table E in § 90.309). A Yes result means the distance is shorter than the minimum distance listed in the respective tables and thus once again, the maximum allowable ERP is simply set to zero.

The eleventh column **90.309 Table B/E Max ERP (W)** contains the maximum allowable ERP established from the rules and above tests, and the twelfth column **Actual ERP (W)** restates the ERP output for each proposed fixed base station from Attachment 3. Finally in the last column, **90.545 Eng. Study,** the end conclusion is a Yes if the proposed ERP exceeds the maximum allowable ERP hence that proposed fixed base station must be included in the interference analysis. If the proposed ERP is less than or equal to the maximum allowable ERP then the end conclusion is No meaning the specific proposed fixed base station complies with protection for the specific television broadcast station.

The tally of fixed base stations from Attachment 4 included in each television broadcaster's interference analysis is given in Table 4.

Table 4. Summation of Potentially Interfering Fixed Base Stations

Call Sign	Situation	Base Station Count
WMBC	Adjacent	76
WNAC	Co-chan	0
WPVI	Co-chan	35
WQPX	Co-chan	61
WEDY	Adjacent	72
WUVP	Adjacent	0

We note upon applying Commission rules that the proposed public safety base stations meet the required separations to WNAC and WUVP. Therefore no further interference analyses regarding those broadcast stations are necessary in this Engineering Study.

Attachment 5, *Determination of Associated-LMR Base Station Distances* is also arranged as a matrix with each of the proposed 99 downstate fixed base stations aligned to each of the three broadcast stations that are either adjacent channel or co-channel to the associated mobile/portable radio units. The matrix contains one compliance test, that being separation distance as given in Table D of § 90.309. After interpolation of the values listed in Table D, the threshold separation distance for a fixed base station with 30-watt associated mobile units is found to be 179 kilometers. The key outcome is found in the final column, **90.545 Eng. Study**, where Yes and No are conclusive statements regarding whether associated roaming mobile units are transmitting elements in the interference protection analysis of a particular television station.

Table 5 gives the tally of proposed fixed base stations with associated mobile radio units from Attachment 5 that are short-spaced to broadcast towers.

The exact number of base stations is not important in this case: if the base station count is nonzero, a roaming mobile radio interference situation with the broadcaster must be examined.

Table 5. Summation of Short-Spaced Fixed Base Stations with Mobiles

Call Sign	Situation	Base Station Count
WFMZ	Co-chan	71
WFUT	Adjacent	99
WPXQ	Co-chan	61

4. Computational Processes for Evaluating Interference *Protection*

4.1 Process Overview

Spectrum sharing between television broadcasters and land mobile radio operators has prior technical works [1]-[4] about estimating the interference environment and evaluating its effects on UHF television signal reception. In addition, waiver requests initiated by commercial operators for the purpose of opening the lower 700-MHz spectrum to new services are now reaching the Commission [5]-[6]. These preceding protection analysis methodologies contain modeling and evaluation approaches and parameter values that have either influenced or been incorporated into this Engineering Study.

We begin by defining the term "study area" which is a central element of interference analysis. Each broadcaster study area subject to interference protection evaluation has unique geographical and technical variables; and, is enclosed by either an analog or a digital service area contour as explained in Section 3. The study area encompasses all interior cells and those cells aligned along the Grade B contour. A "cell" is defined as a square surface area tile with 3-arc second latitude and longitude dimensions. The study area thus extends along all azimuths from the television transmitter site out to the distance at which the field strength falls to the service contour value; and, because of variations in terrain elevation the boundary contour line may take a meandering course.

The TV signal level may be less than the Grade B threshold in some study area cells because of irregular terrain blockage. There is no practicality of interference protection to a TV receiver that lacks sufficient broadcast signal to demodulate desired information content in the first place. Thus "reception of service" is another central element for evaluating the size of the affected viewer population.

With regards to New York State 700-MHz public safety operation, two distinct processes are developed for the evaluation of interference potential to over-the-air television reception. That is because fixed base stations and randomly roaming mobile and portable units form a two-way radio signal partnership. They are inseparable for public safety mission accomplishment, but whereas the fixed base stations permit deterministic solutions, the randomness of mobile operations requires statistical simulations. The basic methodology outline, however, is the same for both:

- Set the input parameter values of the interference situation,
- Compute the desired (D) field strength at a point in a cell under evaluation,
- Compute and sum the undesired (U) field strengths at the point in the cell under evaluation,
- Compare the D/U ratio to the predetermined protection criteria if the cell is predicted to be receiving service,
- Determine the population in the cell if the cell yields a failed D/U ratio,
- Repeat this process until all cells in the study area have been evaluated, and
- Compute the percentage of affected population in the study area.

The entire process flow is performed for each television broadcaster in turn using the broadcaster's actual technical parameters.

The digest shown on the next page is a guide to the many varied analyses performed as a consequence of having to study seven interference situations. The first three columns list the study configuration: whether the proposed operations are co-channel with or adjacent channel to the broadcaster, whether the proposed operations are inside or outside the broadcaster's Grade B service area, and whether the proposed operations involve fixed base stations or mobile radio units. The next four columns list the study parameters: path loss model used, source of the D/U criterion, and whether household receive antenna characteristics are applied to the analysis. The last column references the broadcasters to their particular study.

Digest 2. Interference Study Configurations and Parameters

Channel Type	Grade B Effect	Proposed Operations	Propagation Model	D/U Criterion	Antenna Directivity	Antenna X-Pol	Stations
Co	Inside	Fixed Base	Longley-Rice	90.545	No	Yes	None
Co	Inside	Mobile	Free-Space	90.545	No	No	None
Co	Outside	Fixed Base	Longley-Rice	90.545	Yes	Yes	WPVI_64 WQPX_64
Co	Outside	Mobile	Two-Slope	90.545	Yes	No	WFMZ_69 WPXQ_69
Adj	Inside	Fixed Base	Longley-Rice	OET TM87-1	No	Yes	WMBC_63
Adj	Inside	Mobile	Free-Space	OET TM87-1	No	No	WFUT_68
Adj	Outside	Fixed Base	Longley-Rice	OET TM87-1	Yes	Yes	WEDY_65
Adj	Outside	Mobile	Two-Slope	OET TM87-1	Yes	No	None

4.2 Mobile/Portable Unit Modeling

The reality of mobile radio communications is that its operational characteristics (incident locations, number of simultaneous transmissions, duration of deployment, etc.,) are random across time and space therefore statistical modeling must be employed to produce tractable interference analyses. Monte Carlo simulation is the technique employed to conduct a large number of mobile radio-distribution trials to the extent that the interference estimation results achieve a statistically significant representation of the actual interference environment. Figure 3 is a guide to the automated mobile/portable unit modeling process.

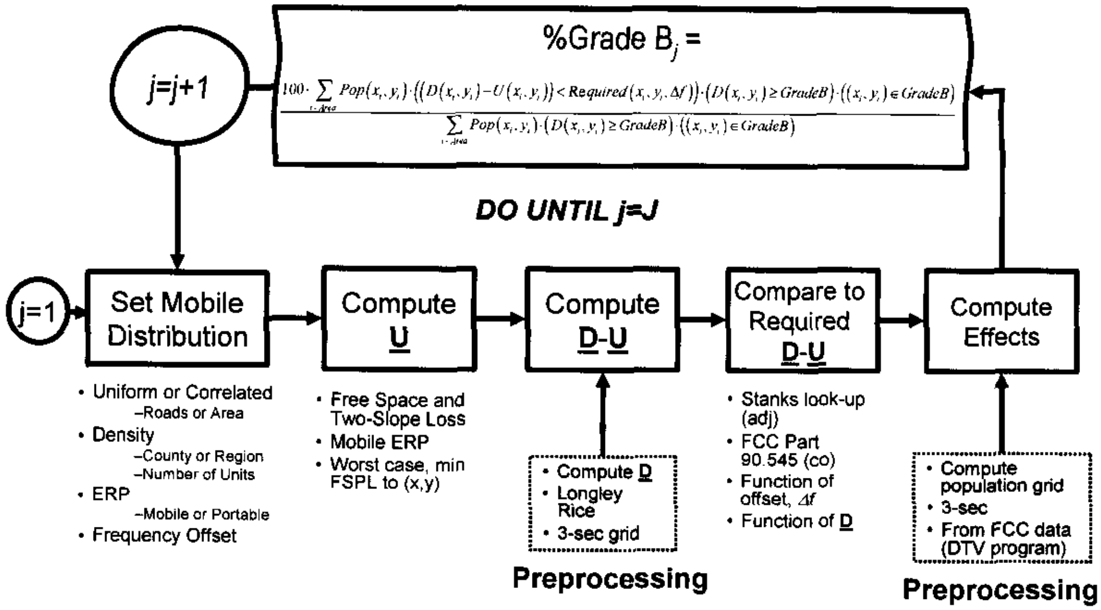

Figure 3. Mobile Radio Interference Evaluation Process

Setting the mobile distribution is what injects placement randomness of roaming mobile locations into the evaluation process. A different assortment of locations (i.e., placements) in each of the twelve counties is automatically created every trial run to simulate movement. The distribution over a county's area is uniform because public safety must be ubiquitous; that is no particular road, village, or other real property receives a biased preference for or against potential operations. The number of placements in a county corresponds to the number of mobile units transmitting simultaneously; in other words this Engineering Study examines different situations involving multiple mobile transmitters. The mobile unit density includes 1, 2, 5, 10, and 25 radios in each of the 12 counties that equates to 12, 24, 60, 120, or 300 simultaneous (not to be confused as the total number of radios deployed in the field) transmitters active during a trial interference run.

The larger numbers of simultaneous transmissions given above are quite optimistic compared to the realities of assigning radio channels with frequency reuse as a system objective plus respecting border sharing of state license channels. Each proposed fixed base station would receive an average of one or two 25-kHz wide state-license 700-MHz channels from the pool of available state license channels (refer to Attachment 2). Thus the range from 12 to 300 simultaneously active channels adequately portrays the range from low to extremely active usage.

While actual operations would see a mix of *predominantly 15 watt mobile* radios with unity gain antennas and 3-watt ERP portable radios in the field, we use the 30-watt ERP for mobile radios exclusively in this Engineering Study because that is the worst-case interference situation and it precludes the numerical mix of mobiles and portables becoming another random variable. For cells with incident power from multiple public safety transmitters, the total interference power is a non-coherent addition (i.e., superposition summing) of the individual power levels. A new set of undesired signal strengths is computed for every trial of the Monte Carlo simulation because the mobile unit locations change for each new trial.

All mobile interference simulations are conducted at a single radio frequency of 803.000 MHz. This simplifying action creates an unrealistic artifact such that all transmitted output power accumulates on one LMR frequency rather than being spread over the broader range of proposed public safety frequencies. We nonetheless choose not to introduce frequency distribution of transmitted power as another random variable, and instead focus on worst-case situations.

The desired television signal strength from the fixed broadcast tower is computed only once per broadcaster since a broadcaster's characterization remains constant throughout the entire Monte Carlo simulation. Median desired field strength at a point in each cell is computed using the Longley-Rice v1.2.2 propagation model [7], 3-arc second resolution digitized terrain, and the FCC's technical data for the particular broadcaster under study (see Table 3, Section 3.)

With the values for D and U computed, converting the numerical ratio of D/U at each service-receiving cell to a logarithmic value yields the actual protection ratio in units of decibels (dB). Recall that a service-receiving cell is defined to be a cell where the median television field strength is no less than the OET Bulletin No. 69 UHF Grade B standard given in Section 3; and, that the cell resides within or on the Grade B service contour [8].

The population count for each study area cell is obtained from U.S. Census Bureau Year 2000 census block data. Census block data are remapped onto the 3-arc second dimensions of the propagation study cells. The outcomes of a single trial are:

- Identification of cells in the study area that receive television service with the receive signal power for each of those cells,
- Identification of which cells in the study area receiving television service that do not meet the relevant D/U criterion,

- Total population count for all cells in the study area that receive television service, and

- Total population count for those cells in the study area that did not meet the relevant D/U criterion.

Many random placements are necessary to achieve statistical significance, that is, convergence about a central value. We use 1,000 or 2,000 trials per each set of mobile units for each broadcaster interference situation. One thousand trials are more than ample to assure convergence of results; however, when the results returned vanishingly small affected populations we extended the trials to 2,000 to be fully assured of that central tendency.

Finally, the figure-of-merit for evaluating the magnitude of the interference effect is the ratio of total population inside the Grade B contour receiving TV service with a failed D/U to the total population inside the Grade B contour receiving TV service.

4.2.1 Mobile Unit Study of Adjacent Channel Station WFUT

The adjacent mobile radio interference situation analysis proceeds in the same manner as just described in Sections 4.1 and 4.2. In this subsection we focus on those characteristic aspects that distinguish modeling upper adjacent public safety channel operations inside the Grade B service area.

Free space path loss, stated as

$$L_{fs}\ (\text{dBi}) = 20 \log_{10} [\text{Frequency (MHz)} \times \text{Distance (km)}] + 32.4,$$

is used to compute the undesired mobile unit signal strength at cells within or on the Grade B service contour of adjacent-channel WFUT. No additional attenuation factors such as land use and coverage, household antenna directivity and cross-polarization isolation, or building penetration losses are applied to the WFUT case study. Overall this is a very conservative approach considering the height of a mobile public safety antenna out in the street is less than 2 meters above ground level. Still we deem unaltered free space path loss to be the appropriate propagation model of mobile units operating inside the Grade B service area.

The regulatory D/U protection criteria for the WFUT upper adjacent channel interference situation is given by FCC/OET Report TM87-1, Figure 4, *Upper adjacent medians for indicated desired levels* [3]. We note in TM87-1, Figure 4 that the regulatory D/U is a function of absolute desired signal levels. *Thus, the protection criterion is itself a variable as opposed to a single static value* because of the effects of frequency selectivity in the television receiver.

The 803.000 MHz mobile interference radio frequency is nearer to WFUT (i.e., is 9-MHz offset above WFUT's lower channel edge) than the first proposed mobile channel Number 1601 at 804.000 MHz. We performed bilinear interpolation of TM87-1, Figure 4 at the offset frequency of 9 MHz to gain finer resolution of D/U protection criteria values. In short, the bilinear interpolation is a two-dimensional interpolation of a given series of (x, y, z) points to generate estimated values for z's at new (x', y') points. The outcome is a computerized lookup table of interference levels, desired signal levels, and the corresponding D/U criteria. There is a further benefit of more pertinent D/U ratios aligned with strong, moderate, and weak television signal conditions.

4.2.2 Mobile Unit Studies of Co-Channel Stations WFMZ and WPXQ

The co-channel mobile radio interference situation analysis proceeds in the same manner as described in Sections 4.1 and 4.2. In this subsection we focus on those characteristic aspects that distinguish modeling co-channel public safety operations outside the Grade B service area.

Whereas WFUT's Grade B service area substantially overlies the proposed downstate area of operations, the Grade B service contour of WFMZ lies fully outside New York State and the WPXQ Grade B service contour just reaches the extreme end of Montauk Point, Long Island (refer to Figure 2, Section 3). For the WFMZ and WPXQ study cases, the free space path loss model is not appropriate for longer distance propagation paths because the very low height mobile transmit antenna experiences near-field, ground-plane limited radiation. The mean received signal power is approximated by an inverse fourth-power law [9].

We select the two-slope – single breakpoint UHF transmission loss model (see for example reference 10) as a non-rigorous approach to account for greater path loss than that predicted by the second power distance law alone in urban and suburban clutter for very low transmitting antennas. A key concept of the model is the breakpoint distance R_{bp} at the transition point from second-power law (20 dB/decade) to fourth-power law (40 dB/decade) as given by

$$R_{bp}\,(\mathrm{m}) \approx 4\,[h_m\, h_r] \,/\, \lambda$$

where:

h_m is the mobile antenna height (1.8 meters),
h_r is the household TV receive antenna height (9.1 meters), and

λ is the wavelength (0.37 meters at 803 MHz.)

Receiving antenna pattern discrimination to off-axis arrival angles is a factor affecting case studies where the Grade B service area is outside the proposed public safety area of operations. The discrimination is calculated as the fourth power of the cosine of the angle (i.e., $\cos^4 \theta$) between the lines joining the broadcaster transmitter and the public safety transmitter to the reception point. The discrimination is never more than 6 dB for UHF analog receiving antennas [11].

There is no frequency selectivity for the co-channel case study therefore the regulatory D/U criterion for protection of analog television is 40 dB as stated in § 90.545(a) at any receive field strength.

4.3 Fixed Base Station Modeling

Figure 4 is a guide to the automated fixed base station modeling process. Attachment 4 identifies (by a Y in the 90.545 Eng. Study column; also see Table 4, Section 3) those base stations that are "active" along with their ERP data for each broadcast station case study of interference to viewers. The public safety base station field strength at a point in each cell of the study area is computed using the Longley-Rice v1.2.2 propagation model [7], 3-arc second resolution digitized terrain, and the site's technical data.

Receiving antenna pattern discrimination to orthogonal polarization is a factor affecting fixed base station case studies. The horizontal-to-vertical discrimination used in this Engineering Study is 10 dB [2]. The total interference (U) in a cell is calculated as the non-coherent power addition for the requisite number of multiple transmitters.

The median desired television signal strength (D) from the fixed broadcast tower at a point in each cell is computed using the Longley-Rice v1.2.2 propagation model, 3-arc second resolution digitized terrain, and the FCC's technical data for the particular broadcaster under study (see Table 3, Section 3.)

With the values for D and U computed, converting the numerical ratio of D/U at each service-receiving cell to a logarithmic value yields the actual protection ratio in units of decibels (dB). Recall that a service-receiving cell is defined to be a cell where the median television field strength is no less than the OET Bulletin No. 69 UHF Grade B standard given in Section 3; and, that the cell resides within or on the Grade B service contour [8].

The population count for each study area cell is obtained from U.S. Census Bureau Year 2000 census block data. Census block data are remapped onto the 3-arc second dimensions of the propagation study cells. The outcomes are:

- Identification of cells in the study area that receive television service with the receive signal power for each of those cells,
- Identification of which cells in the study area receiving television service that do not meet the relevant D/U criterion,
- Total population count for all cells in the study area that receive television service, and
- Total population count for those cells in the study area that did not meet the relevant D/U criterion.

Finally, the figure-of-merit for evaluating the magnitude of the interference effect is the ratio of total population inside the Grade B contour receiving TV service with a failed D/U to the total population inside the Grade B contour receiving TV service.

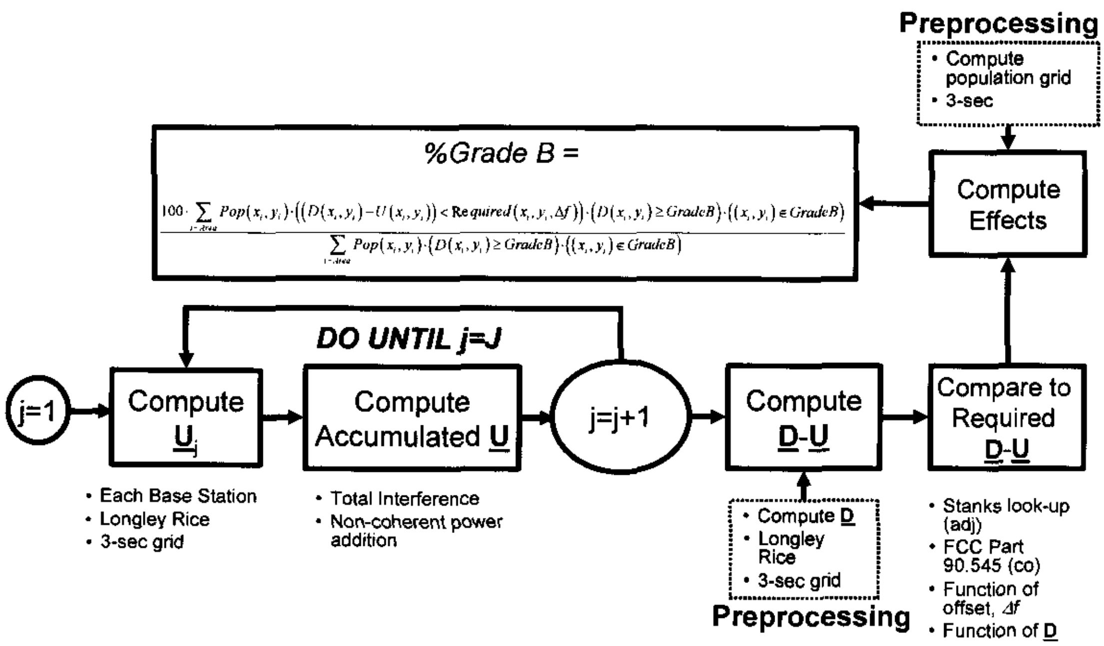

Figure 4. Fixed Base Station Interference Evaluation Process

4.3.1 Base Station Study of Adjacent Channel Station WMBC

The adjacent channel fixed base station interference situation analysis proceeds in the same manner as just described in Sections 4.1 and 4.3. In this subsection we focus on those characteristic aspects that distinguish modeling upper adjacent public safety channel operations inside the Grade B service area.

The regulatory D/U protection criteria for the WMBC upper adjacent channel interference situation is given by FCC/OET Report TM87-1, Figure 4, *Upper adjacent medians for indicated desired levels* [3]. We note in TM87-1, Figure 4 that the regulatory D/U is a function of absolute desired signal levels. Thus the protection criterion is itself a variable as opposed to a single static value because of the effects of frequency selectivity in the television receiver.

The 773.000 MHz base station interference radio frequency is actually closer to WFUT edge (i.e., is 9-MHz offset above WMBC's lower channel edge) than the first proposed base station channel Number 641 at 774.000 MHz. We performed bilinear interpolation of TM87-1, Figure 4 at the offset frequency of 9 MHz to gain finer resolution of D/U protection criteria values as explained in Section 4.2.1. The outcome is a computerized lookup table of interference levels, desired signal levels, and the corresponding D/U criteria.

4.3.2 Base Station Study of Adjacent Channel Station WEDY

The adjacent channel fixed base station interference situation analysis proceeds in the same manner as just described in Sections 4.1 and 4.3. In this subsection we focus on those characteristic aspects that distinguish modeling lower adjacent public safety channel operations outside the Grade B service area.

The regulatory D/U protection criteria for the WEDY lower adjacent channel interference situation is given by FCC/OET Report TM87-1, Figure 2, *Lower adjacent medians for indicated desired levels* [3]. We note in TM87-1, Figure 2 that the regulatory D/U is a function of absolute desired signal levels. Thus, the protection criterion is itself a variable as opposed to a single static value because of the effects of frequency selectivity in the television receiver.

We note in Attachment 2 that the highest base station channel is Number 960 at 776.000 MHz which resides coincident with the lower edge of WEDY's bandwidth. This could be a co-channel, not adjacent channel, interference situation if we do not employ some strategy regarding frequency assignments. Several interference study iterations were necessary to determine how best to employ separation distance (i.e., path loss) as a boost to television receiver frequency selectivity for meeting D/U protection criteria; and, concurrently *achieve the largest suite of frequencies for public safety operations.*

The optimum WEDY solution appears to be: 71 of the 72 proposed base stations (see Table 4 and Attachment 4) may operate on public safety frequencies as close as 150 kHz lower than 776.000 MHz. One station, however, must be voluntarily constrained to operate no closer than 400 kHz lower than 776.000 MHz. That base station is Number 89 in Attachment 3 at geographic location 40° 54′ 35″ N, 73° 06′ 58″ W.

Receiving antenna pattern discrimination to off-axis arrival angles is a factor affecting case studies where the Grade B service area is outside the proposed public safety area of operations. The discrimination is calculated as the fourth power of the cosine of the angle (i.e., $\cos^4 \theta$) between the lines joining the broadcaster transmitter and the public safety transmitter to the reception point. The discrimination is never more than 6 dB for UHF analog service receiving antennas [11].

4.3.3 Base Station Studies of Co-Channel Stations WPVI and WQPX

The co-channel fixed base station interference situation analysis proceeds in the same manner as just described in Sections 4.1 and 4.3. In this subsection we focus on those characteristic aspects that distinguish modeling co-channel public safety operations outside the Grade B service area.

Receiving antenna pattern discrimination to off-axis arrival angles is a factor affecting case studies where the Grade B service area is outside the proposed public safety area of operations. The discrimination is calculated as the fourth power of the cosine of the angle (i.e., $\cos^4 \theta$) between the lines joining the broadcaster transmitter and the public safety transmitter to the reception point. The discrimination is never more than 14 dB for UHF digital service receiving antennas; nor more than 6 dB for UHF analog service receiving antennas [11].

There is no frequency selectivity for the co-channel case study therefore the regulatory D/U criterion for protection of digital television (WPVI) is 17 dB and for analog television (WQPX) is 40 dB as stated in § 90.545(a) at any receive field strength. The base station interference frequency is 773.000 MHz for both studies.

4.4 References

[1] Douglas Prendergast et al, "The Effects of Public Safety Mobile Systems Operations (in TV Channels 63/68) on DTV and NTSC Broadcasting," *IEEE Trans. Broadcasting*, vol. 51, no. 1, March 2005.

[2] Garry C. Hess, "Further Sharing of UHF Television by Private Land Mobile Radio Services," *37th IEEE Vehicular Technology Conference*, June 1987.

[3] Daniel J. Stanks, "Receiver Susceptibility Measurements Relating to Interference Between UHF Television and Land Mobile Radio Services," Federal Communications Commission Report FCC/OET TM87-1, April 1986.

[4] Suneil Kanjeekal, "Public Safety Services within the Television Service Contour," Industry Canada draft paper, May 2005.

[5] Access Spectrum, LLC Request for Waiver of Section 27.60, Federal Communications Commission *Memorandum Opinion and Order*, DA 04-2527, August 12, 2004.

[6] Aloha Partners, L.P. Request for Waiver of Section 27.60, Federal Communications Commission *Memorandum Opinion and Order*, DA 05-460, February 18, 2005.

[7] G. A. Hufford, A. G. Longley, and W. A. Kissick, "A Guide to the Use of the ITS Irregular Terrain Model in the Area Prediction Mode," NTIA Report 82-100, U. S. Dept. of Commerce, April 1982, modifications January 1985.

[8] Robert A. O'Conner, "Understanding Television's Grade A and Grade B Service Contours," *IEEE Trans. Broadcasting*, vol. 47, no. 3, September 2001.

[9] William Gosling, "A Simple Mathematical Model of Co-Channel and Adjacent Channel Interference in Land Mobile Radio," *IEEE Trans. Vehicular Technology*, vol. VT-29, no. 4, November 1980.

[10] William C. Y. Lee, *Mobile Communications Engineering Theory and Applications*, 2ed., New York, The McGraw-Hill Companies, Inc., 1998, pp. 116-120.

[11] "Longley-Rice Methodology for Evaluating TV Coverage and Interference," Federal Communications Commission OET Bulletin No. 69, February 2004.

5. Results of the Protection Analyses

5.1 Composition of the Evaluation Data

The computed numerical size of the affected, or interference, population is the deciding outcome of a multi-step interference analysis. Whereas a single number adequately presents the result, we include figures as visual evidence that the computer-aided analyses have been of consistent rigor for each broadcaster. Each broadcaster's data set consists of:

- A data table giving the computed percentage of affected population,
- A figure displaying the broadcaster's Grade B study area with the computed TV receive signal power shown for each cell, and
- A figure displaying the broadcaster's Grade B study area with the census block population distribution shown within the study area.

The broadcasters subject to the fixed base station interference situation also have a third figure displaying their Grade B study area with cells of computed D/U ratio violations (red dots) with respect to fixed base station locations (blue crosses.)

5.2 Mobile/Portable Unit Studies

The numerical data presented for each broadcaster in this section consists of two tables. The first table provides information and results of the Monte Carlo simulations. The mean population is the result of real interest because this is the central tendency of the trials. The minimum population affected, maximum population affected, and the 99.7% Confidence Interval affected population are provided to indicate where the extremes generally lie.

Convergence is an indication of central value tendency and assures that sufficient trials were conducted. As an example, Figure 5 is the convergence graph for WFUT and shows that convergence occurred at about 200 trials whereas 1,000 trials were actually conducted.

The second table provides the total Grade B service population count and the mean affected population, from the 300 unit simulation, given in two manners: as a mean absolute count and as a ratio of the total service population.

Table 6a. WFUT - Monte Carlo Trials of Multiple Mobile Units

Total Active Mobile Units	Number of Trials	Minimum Population Affected (%)	Mean Population Affected (%)	Maximum Population Affected (%)	Standard Deviation of Population Affected (%)	99.7% Confidence Interval Population Affected (%)
12	1,000	0	0.0075	0.073	0.0070	0.029
24	1,000	0.00057	0.015	0.074	0.0010	0.046
60	1,000	0.0070	0.037	0.20	0.020	0.093
120	1,000	0.020	0.075	0.21	0.023	0.14
300	1,000	0.10	0.20	0.40	0.040	0.32

Table 6b. WFUT- Affected Population Results

Grade B Service Population	Interference Population	% Affected Population
16,559,089	33,449	0.20%

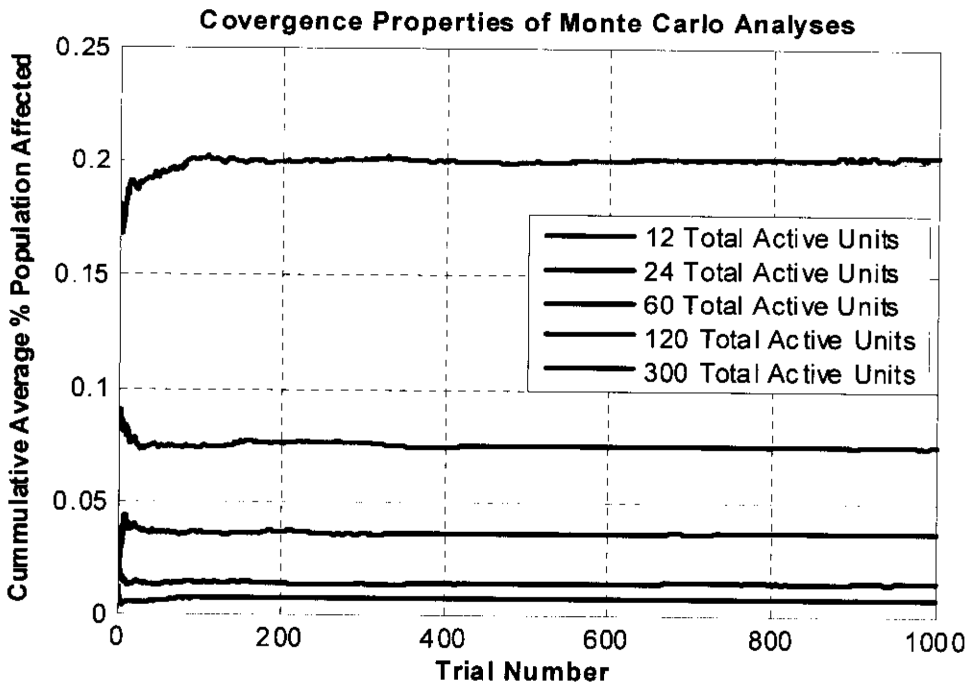

Figure 5. WFUT Convergence Properties

Table 7a. WFMZ - Monte Carlo Trials of Multiple Mobile Units

Total Active Mobile Units	Number of Trials	Minimum Population Affected (%)	Mean Population Affected (%)	Maximum Population Affected (%)	Standard Deviation of Population Affected (%)	99.7% Confidence Interval Population Affected (%)
12	1,000	0	0	0	0	0
24	2,000	0	0	0	0	0
60	2,000	0	0	0	0	0
120	2,000	0	0	0	0	0
300	2,000	0	0.013	0.13	0.022	0.078

Table 7b. WFMZ - Affected Population Results

Grade B Service Population	Interference Population	% Affected Population
3,448,565	434	0.01%

Table 8a. WPXQ - Monte Carlo Trials of Multiple Mobile Units

Total Active Mobile Units	Number of Trials	Minimum Population Affected (%)	Mean Population Affected (%)	Maximum Population Affected (%)	Standard Deviation of Population Affected (%)	99.7% Confidence Interval Population Affected (%)
12	2,000	0	0	0	0	0
24	2,000	0	0	0	0	0
60	2,000	0	0	0	0	0
120	2,000	0	0	0	0	0
300	2,000	0	0	0	0	0

Table 8b. WPXQ - Affected Population Results

Grade B Service Population	Interference Population	% Affected Population
1,253,697	0	0%

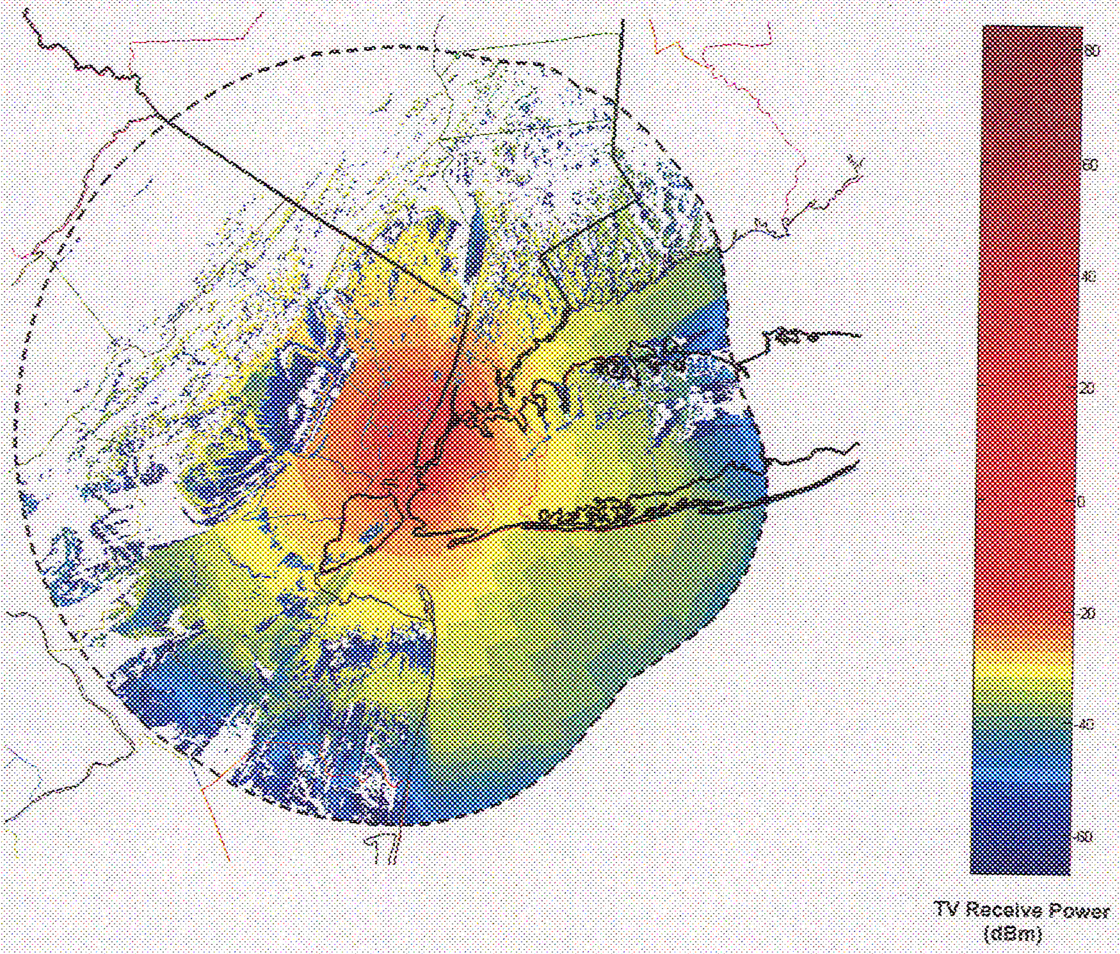

Figure 6a. WFUT Grade B Service Area Signal Level

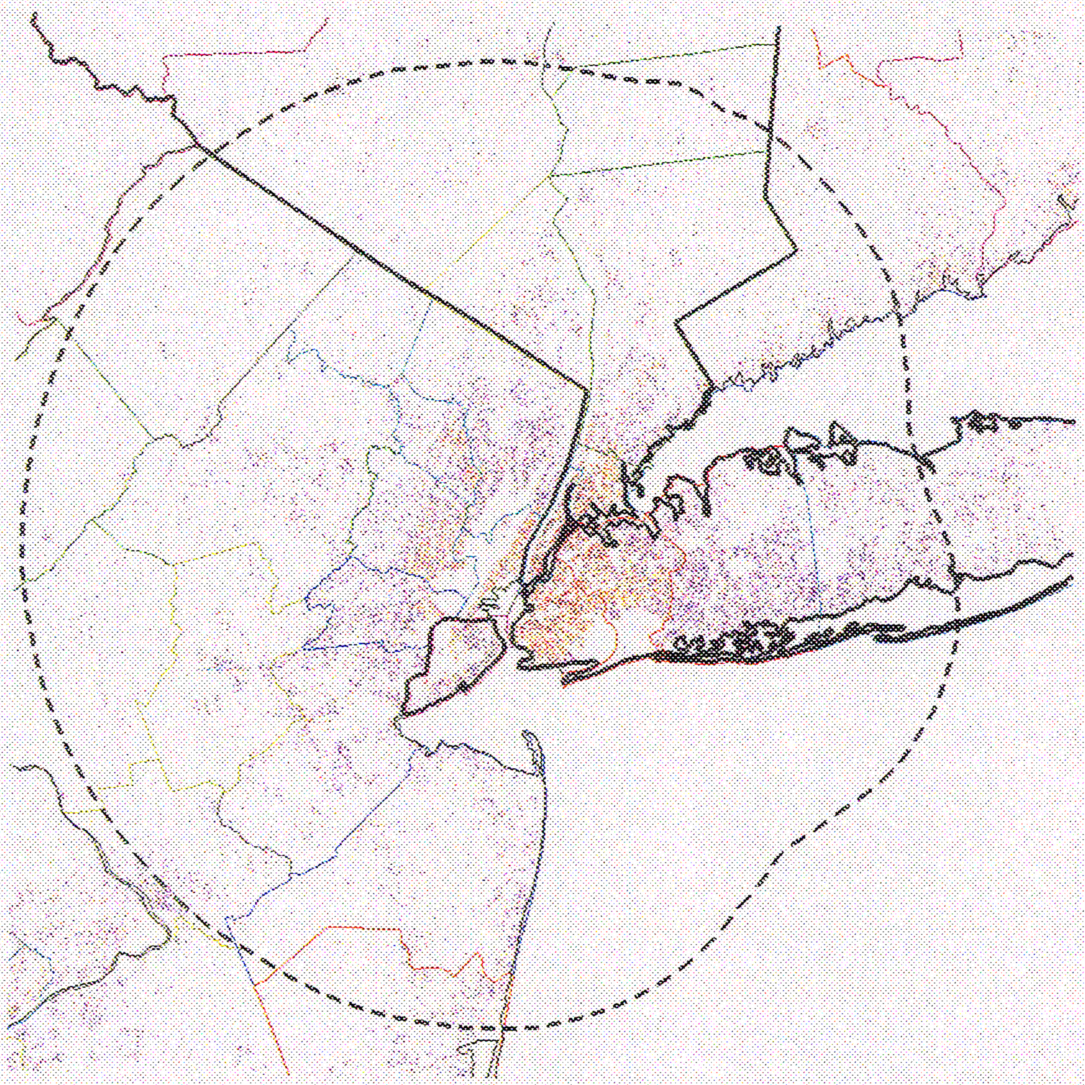

Figure 6b. WFUT Service Area Population Distribution

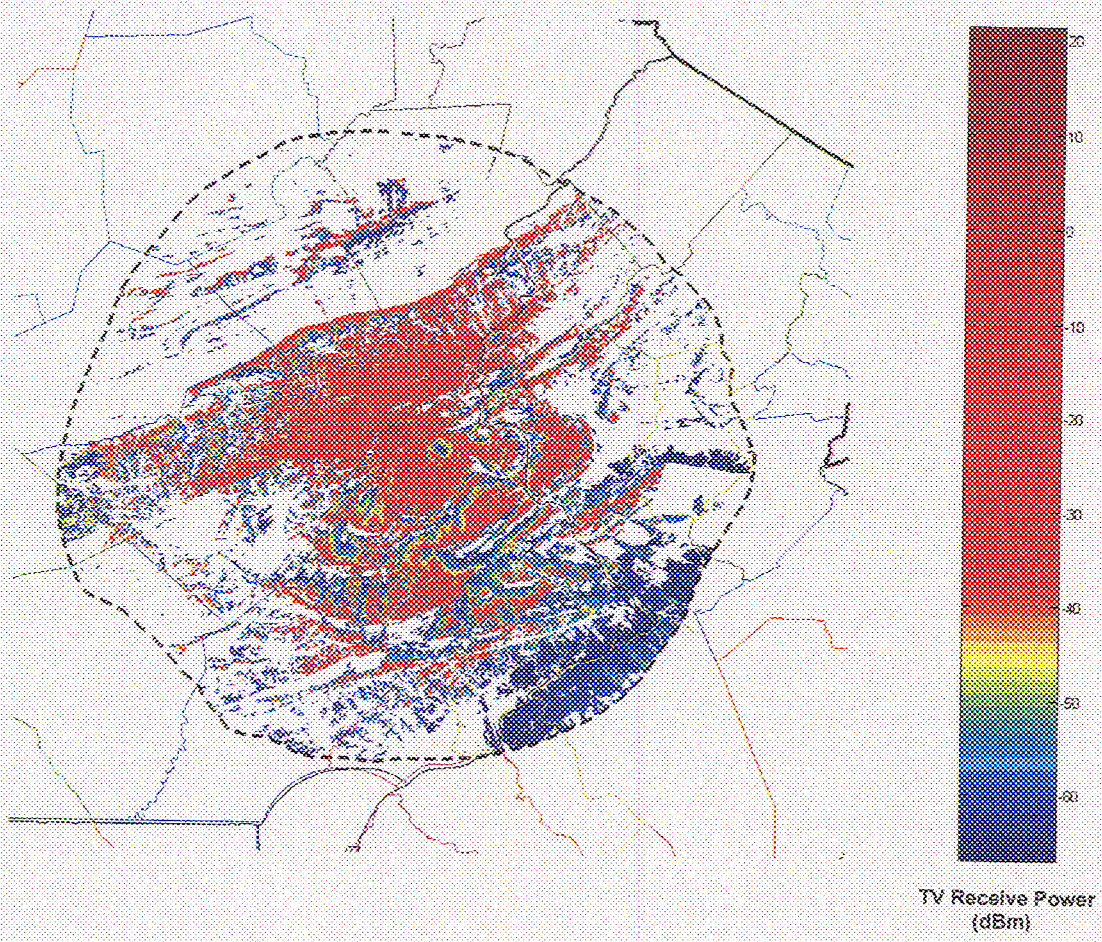

Figure 7a. WFMZ Grade B Service Area Signal Level

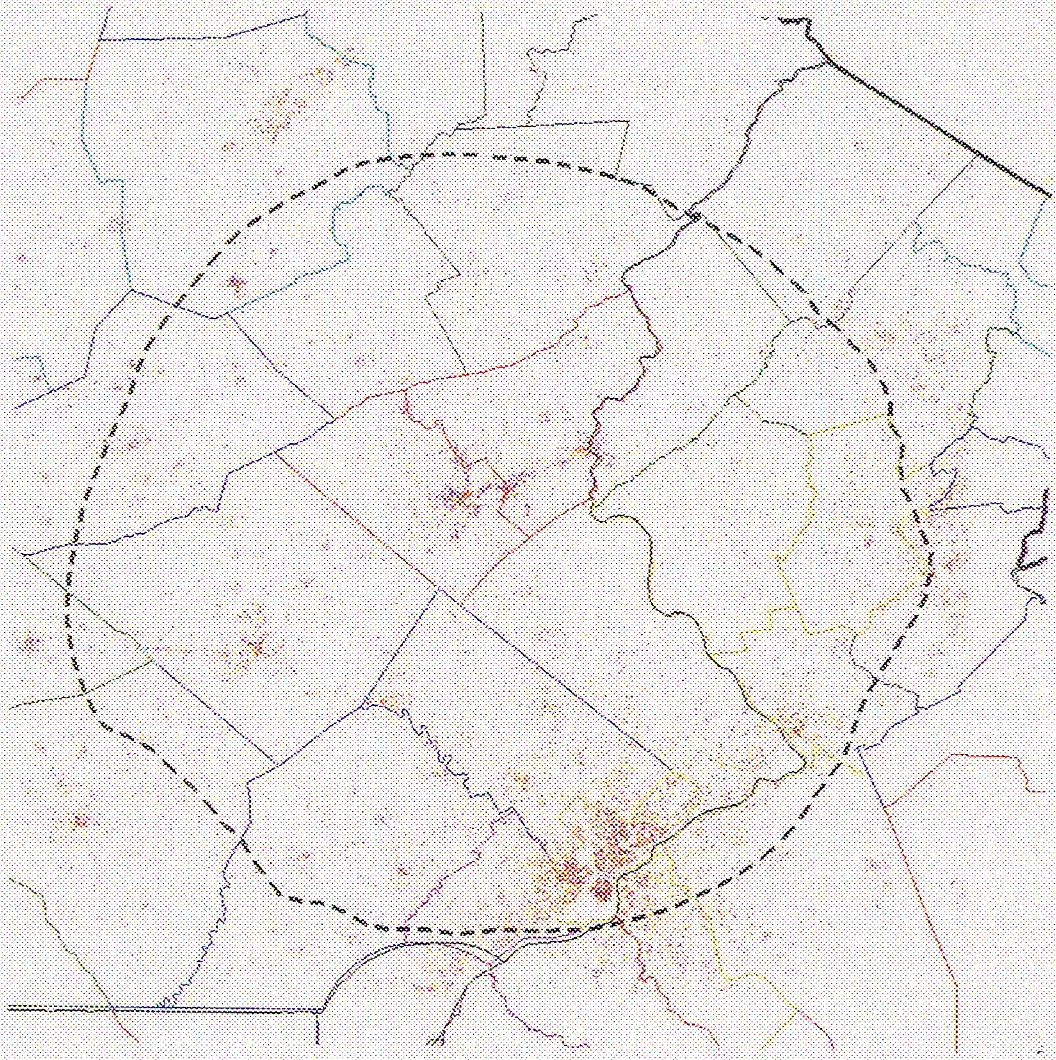

Figure 7b. WFMZ Service Area Population Distribution